# Palaeontological Impact Assessment for the proposed extension of the low grade ore Khumani Mine, Sishen, Northern Province

**Desktop Study**

**For**

**HCAC**

**14 April 2019**

**Prof Marion Bamford**
Palaeobotanist
P Bag 652, WITS 2050
Johannesburg, South Africa
Marion.bamford@wits.ac.za

# Expertise of Specialist

The Palaeontologist Consultant is: Prof Marion Bamford
Qualifications: PhD (Wits Univ, 1990); FRSSAf, ASSAf
Experience: 30 years research; 22 years PIA studies

# Declaration of Independence

This report has been compiled by Professor Marion Bamford, of the University of the Witwatersrand, sub-contracted by Heritage Contracts and Archaeological Consulting (HCAC), Modimolle, South Africa. The views expressed in this report are entirely those of the author and no other interest was displayed during the decision making process for the Project.

Specialist: Prof Marion Bamford

Signature: 

## Executive Summary

A palaeontological Impact Assessment was requested for the proposed expansion of infrastructure for the Khumani Mine at Sishen, Northern cape Province. To comply with the South African Heritage Resources Agency (SAHRA) in terms of Section 38(8) of the National Heritage Resources Act, 1999 (Act No. 25 of 1999) (NHRA), a desktop Palaeontological Impact Assessment (PIA) was completed for the proposed project.

The proposed sites lie on the shales, quartzites and conglomerates of the ancient Gamagara Formation, Olifantshoek Supergroup. There are also some exposures of the Quaternary Kalahari sands. There is an extremely small chance that fossil bones or plant material would occur in Quaternary Kalahari sands where there might be pans or springs. None has been reported from this site. Nonetheless, only because the SAHRIS palaeosensitivity map indicates that the area is very highly sensitive, a Fossil Chance Find Protocol has been included for the EMPr. As far as the palaeontology is concerned, if fossils are found by the responsible person on site, then they should be rescued, photographed and a professional palaeontologist must assess their scientific value.

# Table of Contents

# 1. Background

This application is for the proposed extension of the low grade Khumani Mine, Sishen, Northern Cape Province. To comply with the South African Heritage Resources Agency (SAHRA) in terms of Section 38(8) of the National Heritage Resources Act, 1999 (Act No. 25 of 1999) (NHRA), a desktop Palaeontological Impact Assessment (PIA) was completed for the proposed project.

The proposed expansion will cover approximately 10 ha located on the Farm King 561 near Sishen in the Northern Cape Province. The project includes the construction of the Parson return water dam pipeline, Waste Disposal Facility for return water, water reservoir and a proposed SWD (Figures 1-4). A palaeontological impact assessment (PIA) was carried out in 2017 (Rossouw, 2017) but since then several features have been added to the original plan that fall outside the core area. This PIA includes all four features in the planned expansion.

Table 1: Specialist report requirements in terms of Appendix 6 of the EIA Regulations (2014)

| **A specialist report prepared in terms of the Environmental Impact Regulations of 2014 must contain:** | **Relevant section in report** |
|---|---|
| Details of the specialist who prepared the report | Appendix B |
| The expertise of that person to compile a specialist report including a curriculum vitae | Appendix B |
| A declaration that the person is independent in a form as may be specified by the competent authority | Page 1 |
| An indication of the scope of, and the purpose for which, the report was prepared | Section 1 |
| The date and season of the site investigation and the relevance of the season to the outcome of the assessment | N/A |
| A description of the methodology adopted in preparing the report or carrying out the specialised process | Section 2 |
| The specific identified sensitivity of the site related to the activity and its associated structures and infrastructure | Section ii<br>**Error! Reference source not found.** |
| An identification of any areas to be avoided, including buffers | N/A |
| A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers; | N/A |
| A description of any assumptions made and any uncertainties or gaps in knowledge; | Section 5 |
| A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment | Section 4 |

| | |
|---|---|
| Any mitigation measures for inclusion in the EMPr | N/A |
| Any conditions for inclusion in the environmental authorisation | N/A |
| Any monitoring requirements for inclusion in the EMPr or environmental authorisation | Section 8 |
| A reasoned opinion as to whether the proposed activity or portions thereof should be authorised | N/A |
| If the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan | N/A |
| A description of any consultation process that was undertaken during the course of carrying out the study | N/A |
| A summary and copies if any comments that were received during any consultation process | N/A |
| Any other information requested by the competent authority. | N/A |

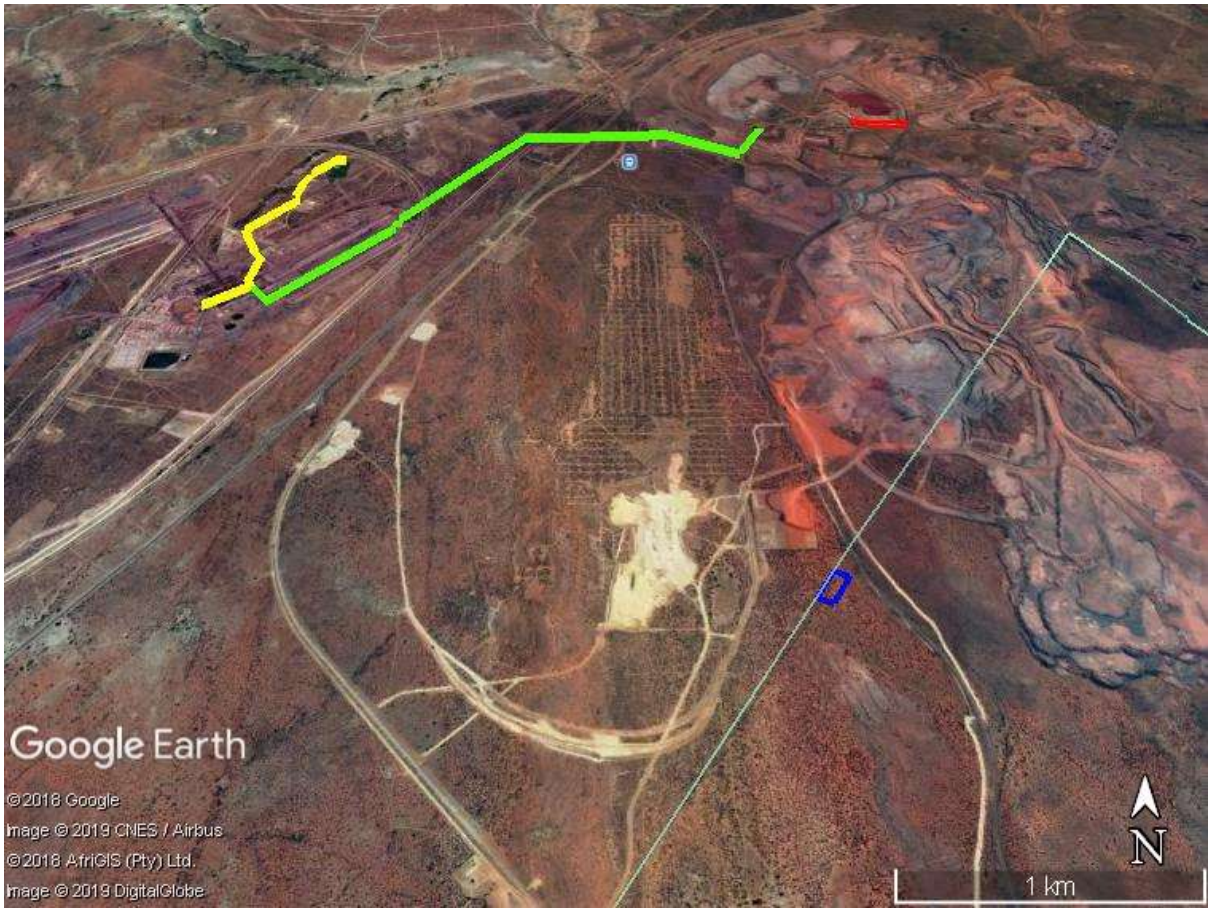


Figure 1: Google Earth map of the proposed area for the four features/facilities to be added to the expansion project for Khumani Mine, Sishen, Northern Cape Province. The features are shown in more detail in the following figures. Yellow line = Parson Return water dam,

Fig. 2; Green = Waste Disposal Facility return water pipeline, Fig. 2; Red = proposed Slimes Water Dam, Fig 3; Blue = water reservoir, Fig 4. Maps supplied by HCACA.

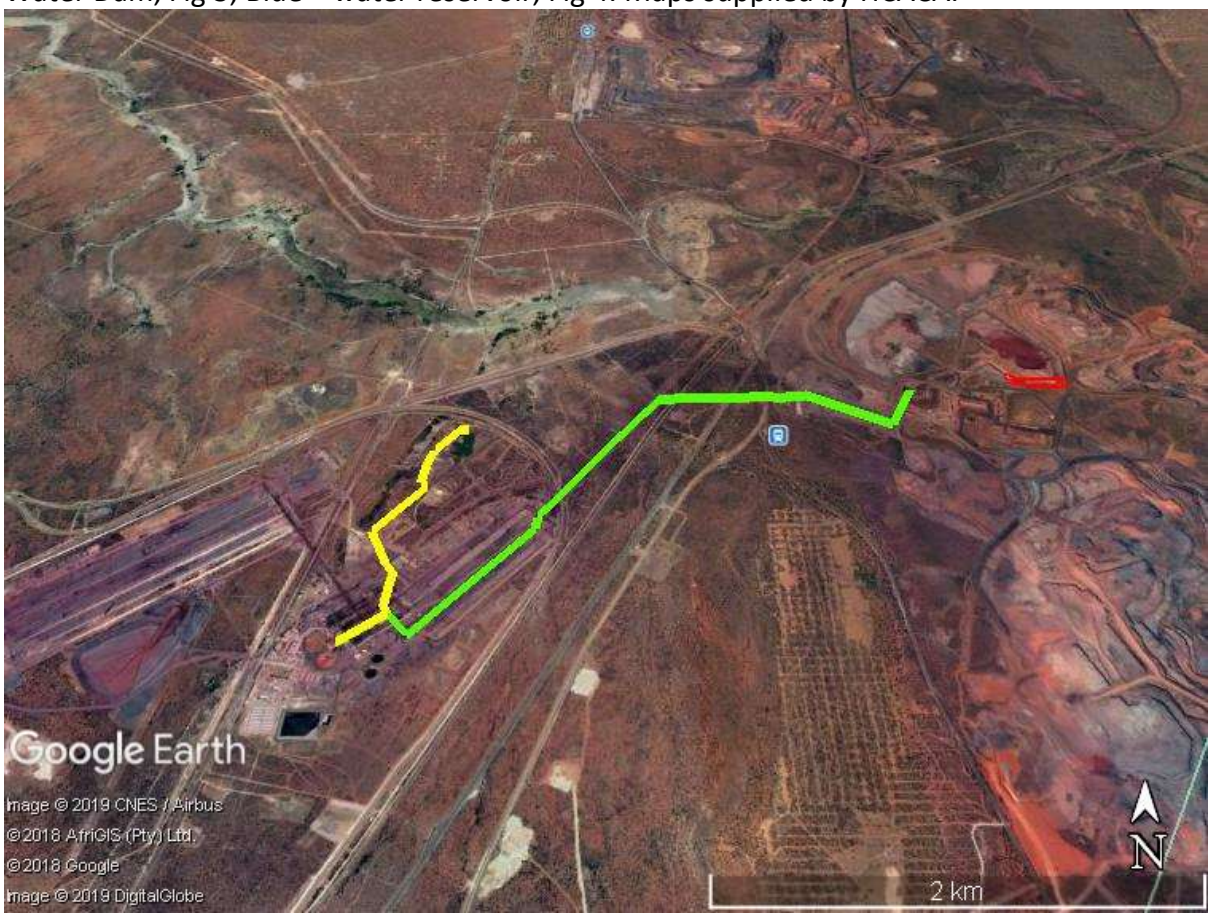


Figure 2: Google Earth map of the proposed expansion to Khumani Mine. Yellow line = Parson Return water dam, and green line = Waste Disposal Facility return water pipeline.


Figure 3: Google Earth map to show the outline and location of the proposed Slimes Water Dam (SWD) for the Khumani Mine expansion project.


Figure 4: Google Earth map of the position of the proposed water reservoir for the Khumani Mine expansion, Sishen,

# 2. Methods and Terms of Reference

The Terms of Reference (ToR) for this study were to undertake a PIA and provide feasible management measures to comply with the requirements of SAHRA.
The methods employed to address the ToR included:

1. Consultation of geological maps, literature, palaeontological databases, published and unpublished records to determine the likelihood of fossils occurring in the affected areas. Sources included records housed at the Evolutionary Studies Institute at the University of the Witwatersrand and SAHRA databases;
2. Where necessary, site visits by a qualified palaeontologist to locate any fossils and assess their importance (*not applicable to this assessment*);
3. Where appropriate, collection of unique or rare fossils with the necessary permits for storage and curation at an appropriate facility (*not applicable to this assessment*); and
4. Determination of fossils' representivity or scientific importance to decide if the fossils can be destroyed or a representative sample collected (*not applicable to this assessment*).

# 3. Geology and Palaeontology

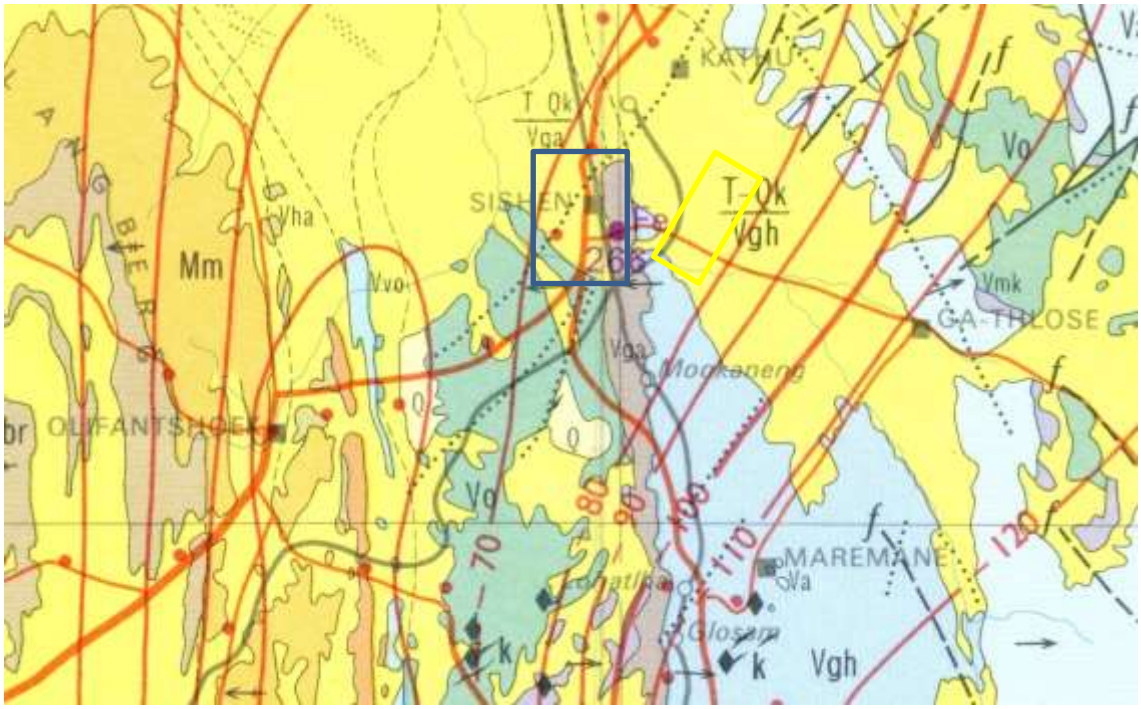


Figure 5: Geological map of the area around Sishen. The location of the Khumani Mine and proposed extensions are outlined by the blue rectangle. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 1 000 000 map 1984.

Table 2: Explanation of symbols for the geological map and approximate ages (Johnson et al., 2006; Moen, 2006; Eriksson et al., 2006). SG = Supergroup; Fm = Formation; Ma = million years.

| Symbol | Group/Formation | Lithology | Approximate Age |
|---|---|---|---|
| Q | Quaternary | Alluvial sands, calcrete | Last 2.5 Ma |
| Vga | Gamagara Fm, Olifantshoek SG | Shale, quartzite, conglomerate | <2050 Ma |
| Vo | Ongeluk Fm, Postmasburg Group, Transvaal SG | Andesite | Ca 2222 Ma |
| Vgh | Ghaap Group, Tvl SG | Dolomite, limestone, chert | Ca 2650 – 2400 Ma |

## i. Project location and geological context

The site lies in the north western part of South Africa on ancient rocks of the Griqualand West Basin (Figures 5, 6) and just north of the Maremane Dome. The Griqualand West Basin is one of three extensive outcrops of the Transvaal Supergroup. Banded iron formation deposits of the Gamagara Formation, basal Olifantshoek Supergroup, are present at Sishen in a very narrow north-south strip and these are younger than, and overlie, the Transvaal Supergroup rocks. Much of these ancient rocks are covered by much younger Quaternary sands, alluvium and calcrete of the Kalahari group.

In the Sishen area the oldest rocks are those of the Ghaap Group, divided into three subgroups, with two formations in the Schmidtsdrif Subgroup, eight in the Campbellrand Subgroup and three in the Asbestos Hills Subgroup.

The Olifantshoek Supergroup is younger than the Transvaal Supergroup. These rocks represent a terrigenous succession that was deposited as a fluvial, clastic wedge that extended along the western edge of the Kaapvaal Craton (Moen, 2006). The basin in which these sediments were deposited was possibly a graben (ibid) and major north-south faults are shown in the maps. The Gamagara Formation is locally feruginised and is composed of coarsening-upward cycles of shale and quartzite. This overlies a basal haematite-pebble conglomerate and unconformably overlies dolomite and iron-formation of the Transvaal Supergroup (ibid). Recent research and 3D-modelling by Stoch and colleagues (2018) has shown that the iron ore body is extensive, strongly controlled by tectonism and faulting and they imply that Fe mineralization at Sishen cannot be exclusively attributed to supergene enrichment and concentric palaeosinkhole formation.

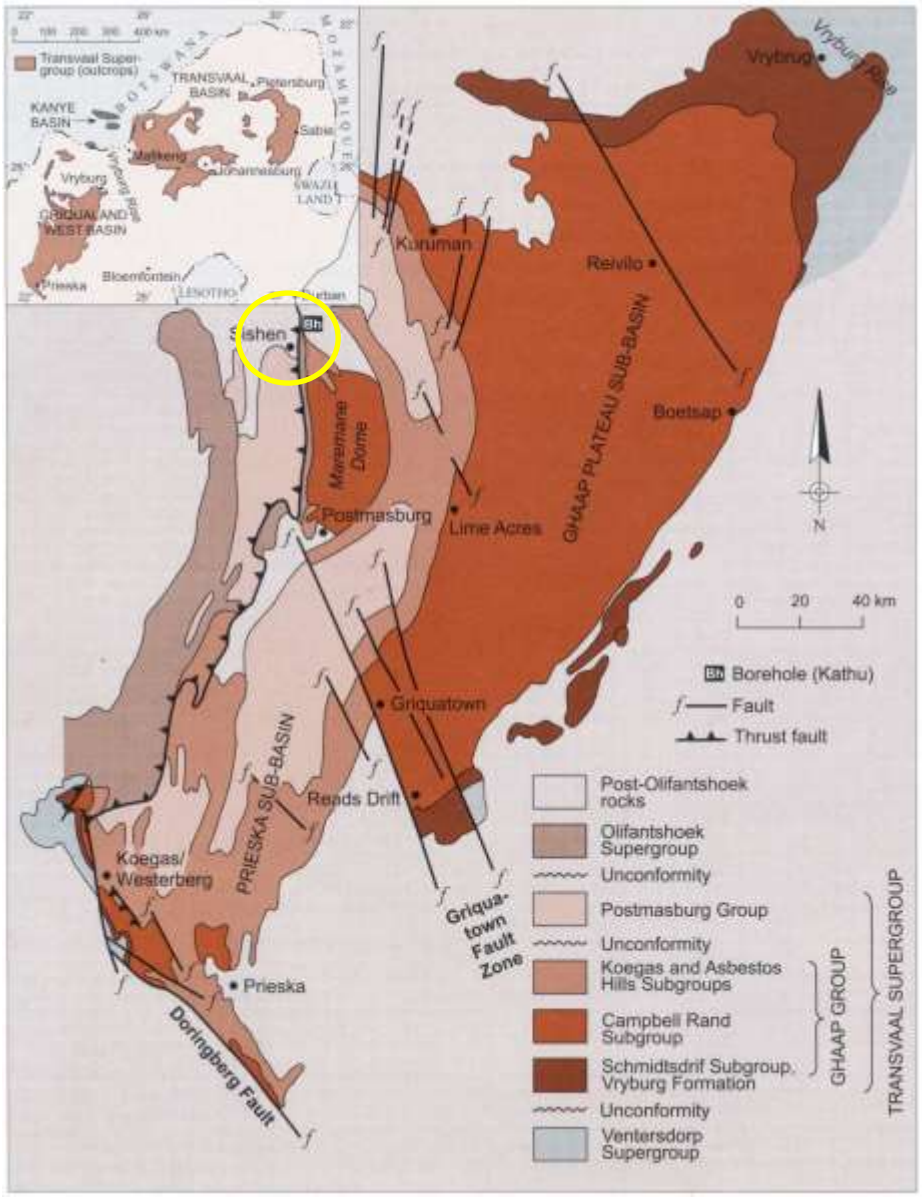


Figure 6: Simplified geological map of the northwestern part of South Africa, the Griqualand West Basin (From Eriksson et al., Fig. 2). Khumani Mine and Sishen are within the yellow circle.

## ii. Palaeontological context

There are some stromatolites in the Transvaal Supergroup rocks but these are not in the footprint of the planned mine expansion. The Gamagara Formation shales, quartzites and conglomerates are not fossiliferous. These are fairly high energy deposits and are too old for the presence of body fossils, being more than 2050 million years old. Photosynthesising algae are crucial for the formation of banded ironstones but indirectly as it is the liberated oxygen that is attracted to the reduced iron and oxidises it to form haematite. The banding has been associated with the seasonal influx or release of oxygen. The iron in the Sishen deposit is a secondarily reworked deposition of iron from the underlying Asbestos Hills Subgroup, Transvaal Supergroup that occurred after erosion, slumping and iron enrichment

of rocks prior to the deposition of the Gamagara Formation. This is not an environment for organisms or their preservation.

The overlying Kalahari sands are alluvial or Aeolian in origin so do not preserve fossils, there are rare examples of fossils being preserved in these young sediments in special settings such as spring mounds (Florisbad, Wonderkrater;; Scott et al., 2003; Scott and Rossouw, 2005) or pans (eg Kathu Pan, Beaumont, 2004; Holmes, 2015). No pans or springs have been recorded from the in the Sishen – Khumani area and are not visible in the Google Earth imagery.

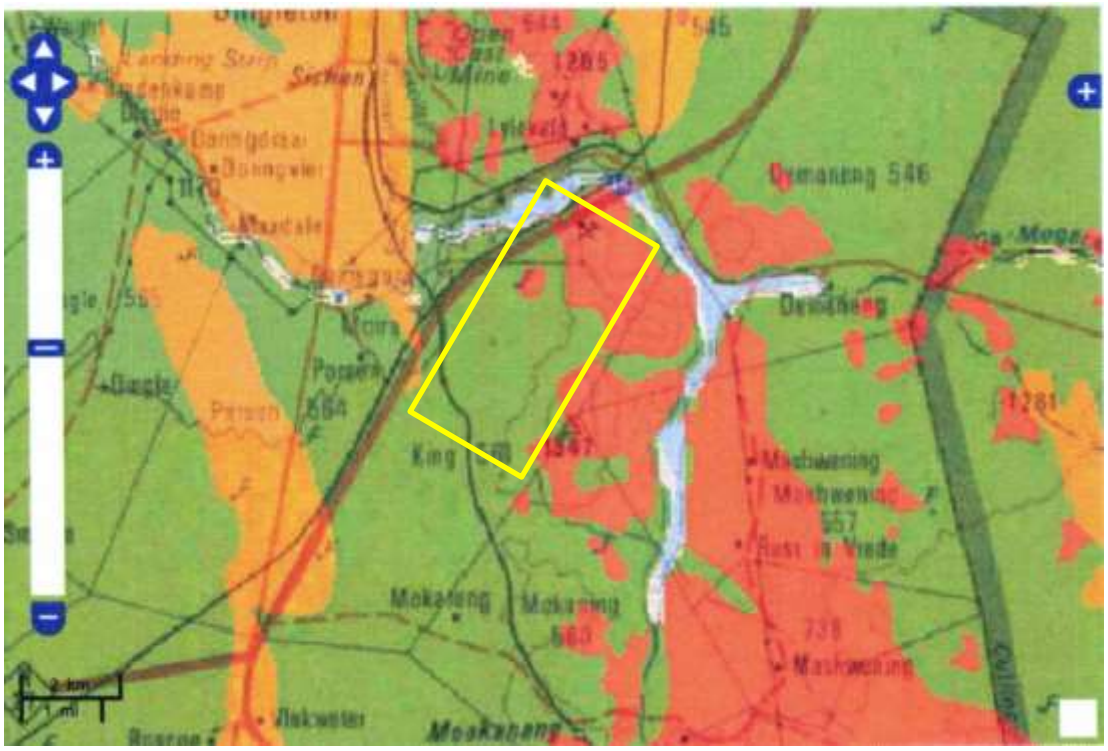


Figure 7: SAHRIS palaeosensitivity map for the site for the proposed expansion to the Khumani Mien, Sishen is indicated within the yellow rectangle but does not include the whole area. Colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

From the SAHRIS map above (Figure 7) the project area is indicated as moderately sensitive (green) so a desktop assessment is being reported upon here; there are also highly sensitive areas that relate to the Quaternary Kalahari sands (red).

Based on the geology of the area the palaeosensitivity map needs to be questioned. The Gamagara Formation is not fossiliferous because it is too old and not of the correct facies to preserve fossils. It should be indicated as insignificant to zero (grey). While there is a small chance of finding fossils in the Kalahari Sands this is restricted to certain geomorphological settings, such as pans and spring mounds, that would have had an ephemeral water source (pans) or permanent water source (springs). A water source would attract animals and

humans in an otherwise rather harsh environment, and then there is a chance of the bones or artifacts, lithics, pottery, etc, being deposited there – and remaining *in situ* only if there is some means of cementing them. The archaeologists target pans and springs for the same reasons as palaeontologists. Thus there is a discrepancy in the interpretation of the palaeosensitivity of the project area.

# 4. Impact assessment

An assessment of the potential impacts to possible palaeontological resources considers the criteria encapsulated in Table :

**TABLE 3A: CRITERIA FOR ASSESSING IMPACTS**

| **PART A: DEFINITION AND CRITERIA** | | |
|---|---|---|
| **Criteria for ranking of the SEVERITY/NATURE of environmental impacts** | **H** | Substantial deterioration (death, illness or injury). Recommended level will often be violated. Vigorous community action. |
| | **M** | Moderate/ measurable deterioration (discomfort). Recommended level will occasionally be violated. Widespread complaints. |
| | **L** | Minor deterioration (nuisance or minor deterioration). Change not measurable/ will remain in the current range. Recommended level will never be violated. Sporadic complaints. |
| | **L+** | Minor improvement. Change not measurable/ will remain in the current range. Recommended level will never be violated. Sporadic complaints. |
| | **M+** | Moderate improvement. Will be within or better than the recommended level. No observed reaction. |
| | **H+** | Substantial improvement. Will be within or better than the recommended level. Favourable publicity. |
| **Criteria for ranking the DURATION of impacts** | **L** | Quickly reversible. Less than the project life. Short term |
| | **M** | Reversible over time. Life of the project. Medium term |
| | **H** | Permanent. Beyond closure. Long term. |
| **Criteria for ranking the SPATIAL SCALE of impacts** | **L** | Localised - Within the site boundary. |
| | **M** | Fairly widespread – Beyond the site boundary. Local |
| | **H** | Widespread – Far beyond site boundary. Regional/ national |
| **PROBABILITY (of exposure to impacts)** | **H** | Definite/ Continuous |
| | **M** | Possible/ frequent |
| | **L** | Unlikely/ seldom |

**TABLE 3B: IMPACT ASSESSMENT**

| **PART B: ASSESSMENT** | | |
|---|---|---|
| **SEVERITY/NATURE** | **H** | - |
| | **M** | - |
| | **L** | There is an extremely small chance that fossil bones or plants occur in the Kalahari sands if there are pans or springs in the site. The impact would be very unlikely. |
| | **L+** | - |
| | **M+** | - |
| | **H+** | - |
| **DURATION** | **L** | - |
| | **M** | - |
| | **H** | Where manifest, the impact will be permanent. |

| PART B: ASSESSMENT | | |
|---|---|---|
| SPATIAL SCALE | L | Since only the possible fossils within the area would be bones or woody plant material in pans or springs, the spatial scale will be localised within the site boundary. |
| | M | - |
| | H | - |
| PROBABILITY | H | - |
| | M | - |
| | L | It is extremely unlikely that any fossils would be found in the surface sediments or even below the surface although they have been reported from other sites, but rarely so. A fossil chance find protocol is included. |

Based on the nature of the project, surface activities may impact upon the fossil heritage if preserved in the development footprint. Underlying rocks of the Gamagara Formation do not contain fossils. Although there is no evidence of pans or springs in the Kalahari sands in the site, fossils and archaeological artifacts have been reported from Kathu Pan to the north. It is extremely unlikely that fossils would occur here, but a Fossil Chance Find Protocol should be added to the EMPr. Taking account of the defined criteria, the potential impact to fossil heritage resources is extremely low.

# 5. Assumptions and uncertainties

Based on the geology of the area and the palaeontological record as we know it, it can be assumed that the formation and layout of the dolomites, shales, sandstones and mudstones are typical for the country and do not could contain fossil vertebrates or plant material. The Quaternary Kalahari Sands do not preserve fossils except rarely in pans or spring sites. These features are not evident from the Google Earth map so it is extremely unlikely that they occur in this site.

# 6. Recommendation

Based on experience and the lack of any previously recorded fossils from the area, it is extremely unlikely that any fossils would be preserved on the surface or below ground. There is an extremely small chance that fossil bones or plant material would occur in Quaternary Kalahari sands where there might be pans or springs. None has been reported from this site. Nonetheless, only because the SAHRIS palaeosensitivity map indicates that the area is very highly sensitive, a Fossil Chance Find Protocol has been included for the EMPr. As far as the palaeontology is concerned, if fossils are found by the responsible person on site, then they should be rescued, photographed and a professional palaeontologist must be consulted to assess their scientific value.

# 7. References


Anderson, J.M., Anderson, H.M., 1985. Palaeoflora of Southern Africa: Prodromus of South African megafloras, Devonian to Lower Cretaceous. A.A. Balkema, Rotterdam. 423 pp.

Beaumont, P.B., 2004. Kathu Pan and Kathu Townlands/Uitkoms. In: Beaumont, P.B., Morris, D. (Eds.), Archaeology in the Northern Cape: Some Key Sites. McGregor Museum, Kimberley, pp. 50-52.

Eriksson, P.G., Altermann, W., Hartzer, F.J., 2006. The Transvaal Supergroup and its pre-cursors. In: Johnson, M.R., Anhaeusser, C.R. and Thomas, R.J., (Eds). The Geology of South Africa. Geological Society of South Africa, Johannesburg / Council for Geoscience, Pretoria. pp 237-260.

Holmes,P. J. 2015. The Western Free State Panfield: A landscape of myriad pans and lunettes. In S. Grab & J. Knight (Eds.), Landscapes and landforms of South Africa. pp. 139–145. Switzerland: Springer.

Johnson, M.R., van Vuuren, C.J., Visser, J.N.J., Cole, D.I., Wickens, H.deV., Christie, A.D.M., Roberts, D.L., Brandl, G., 2006. Sedimentary rocks of the Karoo Supergroup. In: Johnson, M.R., Anhaeusser, C.R. and Thomas, R.J., (Eds). The Geology of South Africa. Geological Society of South Africa, Johannesburg / Council for Geoscience, Pretoria. Pp 461 – 499.

Rossouw, L., 28 June 2017. Palaeontological desktop study of a 10 ha expansion of the Khumani low grade mine at Sishen, Northern Cape Province. Unpublished report for HCAC; 7 pages.

Scott, L., Holmgren, K., Talma, S., Woodborne, S., Vogel, J.C., 2003. Age interpretation of the Wonderkrater spring sediments and vegetation change in the Savanna Biome, Limpopo Province, South Africa. South African Journal of Science 99, 484-488.

Scott, L., Rossouw, L., 2005. Reassessment of botanical evidence for palaeoenvironments at Florisbad, South Africa. South African Archaeological Bulletin 60 (182), 96-102.

Stoch, B., Anthonissen, C.J., McCall, M-J., Basson, I.J., Deacon, J., Cloete, E., Botha, J., Britz, J., Strydom, M., Nel., D., Bester, M., 2018. 3D implicit modeling of the Sishen Mine: new resolution of the geometry and origin of Fe mineralization. Mineralium Deposita 53, 835–853.

## 8. Monitoring Programme for Palaeontology – to commence once the excavations begin.

1. The following procedure is only required if fossils are seen on the surface and when excavations commence.
2. When excavations begin the rocks and sediments must be given a cursory inspection by the environmental officer or designated person. Any fossiliferous material (plants, artifacts, bone) should be put aside in a suitably protected place. This way the construction activities will not be interrupted.
3. Photographs of similar fossil plants must be provided to the developer to assist in recognizing the fossil plants in the shales and mudstones (for example see Figure 1.5). This information will be built into the EMP's training and awareness plan and procedures.
4. Photographs of the putative fossils can be sent to the palaeontologist for a preliminary assessment.
5. As required and to be agreed upon by the developer and the qualified palaeontologist sub-contracted for this project, the palaeontologist should visit the site to inspect the selected material and check the samples where feasible. The frequency of inspections should be determined by the finding of interesting material. However, if the onsite designated person is diligent and extracts the fossil material then inspections can be less frequent.
6. Fossil plants or vertebrates that are considered to be of good quality or scientific interest by the palaeontologist must be removed, catalogued and housed in a suitable institution where they can be made available for further study. Before the fossils are removed from the site a SAHRA permit must be obtained. Annual reports must be submitted to SAHRA as required by the relevant permits.
7. If no good fossil material is recovered then the site inspections by the palaeontologist can be reduced to annual events until construction has ceased. Annual reports by the palaeontologist must be sent to SAHRA.
8. If no fossils are found and the excavations have finished then no further monitoring is required.

Appendix B – Details of specialist

# Curriculum vitae (short) - Marion Bamford PhD
# January 2019

### I) Personal details

| | | |
|---|---|---|
| Surname | : | **Bamford** |
| First names | : | **Marion Kathleen** |
| Present employment | : | Professor; Director of the Evolutionary Studies Institute. Member Management Committee of the NRF/DST Centre of |

Excellence Palaeosciences, University of the Witwatersrand, Johannesburg, South Africa-
Telephone : +27 11 717 6690
Fax : +27 11 717 6694
Cell : 082 555 6937
E-mail : marion.bamford@wits.ac.za ; marionbamford12@gmail.com

**ii) Academic qualifications**

Tertiary Education: All at the University of the Witwatersrand:
1980-1982: BSc, majors in Botany and Microbiology. Graduated April 1983.
1983: BSc Honours, Botany and Palaeobotany. Graduated April 1984.
1984-1986: MSc in Palaeobotany. Graduated with Distinction, November 1986.
1986-1989: PhD in Palaeobotany. Graduated in June 1990.

**iii) Professional qualifications**

*Wood Anatomy Training (overseas as nothing was available in South Africa)*:
1994 - Service d'Anatomie des Bois, Musée Royal de l'Afrique Centrale, Tervuren, Belgium, by Roger Dechamps
1997 - Université Pierre et Marie Curie, Paris, France, by Dr Jean-Claude Koeniguer
1997 - Université Claude Bernard, Lyon, France by Prof Georges Barale, Dr Jean-Pierre Gros, and Dr Marc Philippe

**iv) Membership of professional bodies/associations**

Palaeontological Society of Southern Africa – 1984 to present
Royal Society of Southern Africa - Fellow: 2006 onwards
Academy of Sciences of South Africa - Member: Oct 2014 onwards
International Association of Wood Anatomists - First enrolled: January 1991
International Organization of Palaeobotany – 1993+
Botanical Society of South Africa
South African Committee on Stratigraphy – Biostratigraphy - 1997 - 2016
SASQUA (South African Society for Quaternary Research) – 1997+
PAGES - 2008 –onwards: South African representative
ROCEEH / WAVE – 2008+
INQUA – PALCOMM – 2011+onwards

**vii) Supervision of Higher Degrees**

All at Wits University

| Degree | Graduated/completed | Current |
|---|---|---|

| | | |
|---|---|---|
| Honours | 6 | 1 |
| Masters | 8 | 1 |
| PhD | 10 | 3 |
| Postdoctoral fellows | 9 | 3 |

**viii) Undergraduate teaching**
Geology II – Palaeobotany GEOL2008 – average 65 students per year
Biology III – Palaeobotany APES3029 – average 25 students per year
Honours – Evolution of Terrestrial Ecosystems; African Plio-Pleistocene Palaeoecology; Micropalaeontology – average 2-8 students per year.

**ix) Editing and reviewing**
Editor: Palaeontologia africana: 2003 to 2013; 2014 onwards – Assistant editor
Guest Editor: Quaternary International: 2005 volume
Member of Board of Review: Review of Palaeobotany and Palynology: 2010 –
Cretaceous Research: 2014 -

Review of manuscripts for ISI-listed journals: 25 local and international journals

# x) Palaeontological Impact Assessments

Selected – list not complete:

- Thukela Biosphere Conservancy 1996; 2002 for DWAF
- Vioolsdrift 2007 for Xibula Exploration
- Rietfontein 2009 for Zitholele Consulting
- Bloeddrift-Baken 2010 for TransHex
- New Kleinfontein Gold Mine 2012 for Prime Resources (Pty) Ltd.
- Thabazimbi Iron Cave 2012 for Professional Grave Solutions (Pty) Ltd
- Delmas 2013 for Jones and Wagener
- Klipfontein 2013 for Jones and Wagener
- Platinum mine 2013 for Lonmin
- Syferfontein 2014 for Digby Wells
- Canyon Springs 2014 for Prime Resources
- Kimberley Eskom 2014 for Landscape Dynamics
- Yzermyne 2014 for Digby Wells
- Matimba 2015 for Royal HaskoningDV
- Commissiekraal 2015 for SLR
- Harmony PV 2015 for Savannah Environmental
- Glencore-Tweefontein 2015 for Digby Wells
- Umkomazi 2015 for JLB Consulting
- Ixia coal 2016 for Digby Wells
- Lambda Eskom for Digby Wells
- Alexander Scoping for SLR
- Perseus-Kronos-Aries Eskom 2016 for NGT
- Mala Mala 2017 for Henwood

- Modimolle 2017 for Green Vision
- Klipoortjie and Finaalspan 2017 for Delta BEC
- Ledjadja borrow pits 2018 for Digby Wells
- Amandelbult 2018 for SRK
- Lungile poultry farm 2018 for CTS
- Olienhout Dam 2018 for JP Celliers
- Isondlo and Kwasobabili 2018 for GCS
- Kanakies Gypsum 2018 for Cabanga
- Nababeep Copper mine 2018
- Glencore-Mbali pipeline 2018 for Digby Wells
- SARAO 2018 for Digby Wells
- Ventersburg B 2018 for NGT
- Hanglip Service Station 2018 for HCAC

## xi) Research Output

Publications by M K Bamford up to January 2019 peer-reviewed journals or scholarly books: over 125 articles published; 5 submitted/in press; 8 book chapters.
Scopus h index = 27; Google scholar h index = 30;
Conferences: numerous presentations at local and international conferences.

## xii) NRF Rating

NRF Rating: B-2 (2016-2020)
NRF Rating: B-3 (2010-2015)
NRF Rating: B-3 (2005-2009)
NRF Rating: C-2 (1999-2004)